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Differential Tariffs, Negative Value-Added and the Theory of Effective Protection

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Differential Tariffs, Negative Value-Added and the Theory of Effective Protection

By AUGUSTINE H. H. TAN*

The theory of effective protection (*EP*), as developed[1] by W. M. Corden (1966) and Harry Johnson, rests on the two critical assumptions of Leontief production coefficients and partial equilibrium.[2] Recent attempts by James Leith, Benton Massell, and Seija Naya and James Anderson to relax the assumption of fixed coefficients have all been in partial equilibrium terms.

In this article, we examine some of the implications for *EP* theory of allowing variable factor proportions and general equilibrium repercussions. It is shown that, under such conditions, (a) *EP* rankings do not necessarily provide any index of economic efficiency even when negative value-added occurs (Sections I and II); (b) *EP* rates do not necessarily measure the maximum proportionate increase in factor rewards (Sections III and IV); and (c) *EP* rankings do not unambiguously indicate the direction of resource flows[3] (Section V).

I. *An Economic Interpretation of Negative Value-Added*

The setting of our problem is an economy with a structure of differential protection such that consumption goods are heavily protected while material (intermediate) imports come in with little or no nominal protection (construed to be tariffs or quotas, or both). The economy has little or no monopoly power in international trade, so that external prices are fixed. Such an economy is characteristic of many less developed countries. (See McKinnon, p. 585.) We assume that the economy has adjusted to the tariff structure, and that the exchange rate is fixed. Let each industry, i, whose value-added we want to measure be in competitive equilibrium with a constant returns to scale production function, earning zero or normal profits. Each factor of production is paid its marginal product, assumed to be the same everywhere. Domestic product prices are fixed by the small country assumption and the given product tariff.

Let us then denote gross output of industry i by Z_i, and the corresponding production function as

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[1] V. K. Ramaswami and T. N. Srinivasan's paper is a further development of the point about resource allocation made in the present article. Corden's forthcoming paper and my January 1969 paper have recently put *EP* theory, with fixed coefficients, into a general equilibrium framework.

W. P. Travis' paper, although dealing with general equilibrium repercussions, does not make the points raised here.

[2] Although Corden (1966) raises some general equilibrium issues here and there, he does not have a consistent model for the purpose. The use of only one primary factor presents problems of knife-edged instability.

[3] These findings throw into doubt other claims based on *EP* rates, such as comparative advantage rankings made, for example, by Bela Balassa and Daniel Schydlowsky.

$$(1)\quad Z_i = Z_i(B_1, B_2 \ldots B_n; M_1, M_2 \ldots M_r)$$

where the B_i's refer to primary factors and the M_j's are intermediate inputs. For simplicity, but without any loss of generality, we dispense with all but one intermediate input, M, and one domestic factor, B. Consider the conventional measure of value-added:

$$(2)\qquad W_i = P_iZ_i - P_mM$$

Value-added, W_i, is defined as gross value of output, P_iZ_i less the value of intermediate input, P_mM.

Since we are dealing with a small country, external prices denoted with asterisks are fixed; then, if no tariff is redundant:

$$(3)\qquad P_i = (1 + t)P_i^*$$

and

$$P_m = P_m^*$$

The price of Z_i is one plus t times its world price, where t is the ad valorem tariff rate. Letting intermediate input in duty free, $P_m = P_m^*$, amounts to differential protection.

Consider then the procedure underlying empirical measures of value-added in world prices. Data on Z_i and M are obtained together with world prices, actual or imputed, and the following value-added in world prices, W_i^* is computed:

$$(4)\qquad W_i^* = P_i^*Z_i - P_m^*M$$

Recalling our price relationships (3) we can then write:

$$(5)\qquad W_i^* = \frac{P_iZ_i - P_mM(1 + t)}{1 + t}$$

Comparing W_i and W_i^* from equations (2) and (5) we can readily see that W_i^* may be negative, depending on the magnitude of M and t, while W_i, domestic value-added may be positive. Therefore, value-added, measured in world prices may be negative.[4] The question then is: what is the economic inference that should be drawn from this empirical observation? Equation (5), if it is negative, appears to tell us that in terms of foreign exchange, we are throwing money down the drain if the industry is allowed to operate. However, the following analysis will demonstrate that this could be a highly misleading, in fact, erroneous interpretation. In the first place, equation (5) is *not* an equilibrium observation; it will be shown that efficient, indeed optimal, behavior of individual industries under constraints provided by a differential tariff policy may easily lead to measured negative value-added in world prices.

Consider the horizontal line AA in Figure 1. This line is defined by the material equivalent[5] of a unit of output under world prices, given by the distance OA, where M assumes the value,

$$M^* = \frac{P_i^*}{P_m^*}$$

That is, M^* denotes the amount of material that may be obtained by exchanging one unit of output under world prices.

Similarly, the material equivalent of a unit of output under domestic prices is given by the distance OH (line HH), where M assumes the value;

[4] The phenomenon of value-added turning negative when measured in world prices seems to be prevalent in many less developed countries using differential protection as a means of fostering industrialiation. See Ronald Soligo and Joseph Stern. Various explanations of such observations range from the existence of gross economic inefficiency to the arguments by Giorgio Basevi (p. 150), and Paul Ellsworth (p. 401), that such results are absurd. The only paper offering the economic rationale, though without elaboration, is by Stephen Lewis and Steve Guisinger.

It should be noted that the purpose is not to deny the validity of arguments based on economic inefficiency; rather it is to highlight the adjustments necessitated by changes in the price regime and the consequences of variability in input coefficients.

[5] I am indebted to Paul David's papers (1962, 1966) in developing the arguments around the concept of material equivalent of a unit of output.

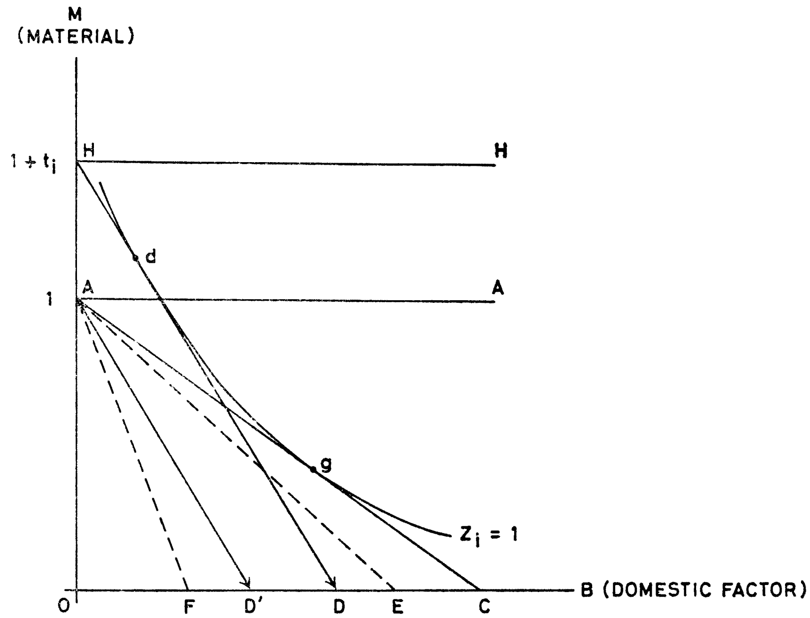

FIGURE 1

$$M^t = \frac{P_i}{P_m}$$

It should be noted that *neither OA nor OH* in Figure 1 denote *actual* material input. The introduction of the notion of material equivalents of a unit of output allows us to bring in output price *levels* into the analysis. Material input thus serves as a convenient numeraire.

Without loss of generality, we can normalize world prices to one:

$$P_m = P_m^* = P_i^* = 1$$

Then, assuming no redundancy in the tariff,

$$P_i = 1 + t$$

We can therefore write the material equivalents of a unit of output as:

$$(6) \quad \begin{aligned} &HH\colon M^t = 1 + t, \text{ domestic price regime} \\ &AA\colon M^* = 1, \text{ world price regime} \end{aligned}$$

Now, consider a point such as d in Figure 1. Point d gives us *positive* value-added in domestic prices because the amount of material used is less than HH. In terms of world prices, however, d represents negative value-added because the amount of material used is greater than the material equivalent of a unit of output in world prices, i.e. d is above AA. But what does the point d represent? In competitive equilibrium, *it is the resultant of the marginal equivalences between the unit isoquant and prices of output and of inputs, the latter defined with respect to the domestic price regime.* Therefore, point d is *not* an equilibrium observation with respect to world prices. The correct interpretation of the measured negative value-added as represented by point d depends on the level of analysis and type of policy being considered.

Case 1

Suppose the industry being considered is a small economic unit, such that a change in policy, relevant only to this industry, has no factor price or other repercussions. It is in equilibrium at point d, with HD yielding the internal factor-price ratio. Under cost minimization, it is just breaking even with the given prices of output, imported material, and the domestic factor. Consider this industry in the absence of *its* output tariff protection. The resulting decrease in product price may be represented in Figure 1, by moving from HH to AA, the world price material equivalent of a unit of output. Since no factor-price changes are induced by the tariff removal, the relevant factor-price line becomes AD', which is parallel to HD. This means, of course, that the industry must go out of business upon removal of its tariff protection, since it would then find it impossible to cover unit costs of production.

Case 2

Next, consider the case of a small industry such as in Case 1. However, the policy change contemplated is a revamping of the entire, or a substantial portion of the tariff structure. This will then mean that relative factor-material prices will be altered. (See Section III.) Suppose that along with the aggregate tariff changes, the tariff for our industry is removed. Then, as in Case 1, we move down from HH to AA. Factor-material price changes, however, could be in either direction, i.e., the domestic factor could become dearer or cheaper. In Figure 1, AF represents an increase in the price of domestic factor, B. Given the usual convexity properties of the isoquant, for the industry to be viable under the new tariff policy, the domestic factor has to be sufficiently cheaper. The price line AC, for instance, satisfies this requirement with equilibrium point g being attained. The line AE, though representing a cheapening of the domestic factor, does not allow unit costs to be covered. A fortiori, price line AF indicates nonviability without protection.

Therefore, in Case 2, with a small industry faced with a significant policy change, it is possible for the industry to be economically *viable without protection, even though it displays measured negative value-added in terms of world prices.*

Case 3

A third possible case is that of an industry which is significant enough such that a change in its rate of protection will generate some relative material factor-price change. A reduction of protection to this industry, with no changes in rates of protection in other industries, will lead to a contraction of the industry, decreasing its demand for the domestic factor. The industry will continue functioning so long as the domestic factor becomes sufficiently cheap to allow the industry to cover unit costs, e.g. point g in Figure 1.

Case 4

Next, consider the general version of Case 3 where the industry is big enough to affect domestic factor prices but such repercussions depend on changes in the rates of protection in other industries as well.

Again, in this case, as for Case 2, (with the exception that the factor intensity of the industry in Case 4 is relevant to factor-price changes), the domestic factor may become cheaper or dearer when the policy change of, say, removing the industry's tariff protection, is instituted. The relevant material factor price line may be AF, AE, or AC. AF and AE represent nonviability, as in Case 2. However, if the price line is AC, with equilibrium point g, the industry will continue functioning.[6]

What about those industries displaying positive value-added in world prices? Our analysis suggests that analogous considerations apply. Just as measured negative value-added in world prices should create

[6] The analysis can be extended to cover questions of tariff redundancy, unimputed surplus, and a tariff on material imports without altering the conclusions.

no undue presumption of the industry being nonviable under world prices (except for Case 1), measured positive value-added in world prices should not create a presumption of viability under world prices, either (Case 1 *not* excepted). It is easily seen that for Case 1, measured positive value-added in world prices is no guarantee of viability under world prices—only when the point d coincides with the point g will the industry continue functioning under world prices. *But, this will happen only if the tariff was completely redundant initially.* Thus, for all practical purposes, and in the absence of technological change, all industries under Case 1 are nonviable when individual tariff protection is removed.

The analysis of measured positive value-added in world prices under Cases 2, 3 and 4 is analogous to the analysis of negative value-added, i.e. the industry may or may not be viable under world prices, no matter whether measured value-added in terms of world prices is positive or negative.

II. *A Special Case: Leontief Technology*

Up to now, we have assumed a variable-input technology. What about a Leontief technology, which excludes substitution between inputs? It can easily be shown that (i) all industries with measured negative value-added in world prices will be nonviable under world prices, for all four cases of Section I; (ii) all industries with measured positive value-added in world prices will be nonviable without individual tariff-protection (Case 1) except in the trivial case of complete tariff redundancy or unimputed monopoly gains; and (iii) in Cases 2, 3, and 4, all industries with measured positive value-added may, or may not, be viable under world prices, depending on relative material-factor prices, as in the case of variable input technology.

Thus the Leotief technology case appears as a special case of our earlier analysis. We may note that it is this special case which, implicitly for the most part, underlies much of the discussion on negative value-added. The natural question arises: how appropriate or inappropriate is the assumption of a fixed coefficient technology? The proper response to this is, that it is an empirical question, and that to proceed to policy measures solely on an assumption may be highly misleading. Indeed, one can argue plausibly that the high incidence (see Soligo and Stern) of measured negative value-added in world prices creates a good presumption of a variable input technology *unless*, of course, all such industries did not exist prior to the introduction of the tariff structure.[7] The argument is self-evident: if the industries existed, i.e. were viable, in the pre-tariff situation, then negative value-added in world prices cannot occur in the post-tariff situation if no factor substitution is allowed and if, of course, no technical retrogression occurs.

It seems much more satisfactory, therefore, to treat the Leontief technology case as no more than a special case and to rest the analysis[8] on the safer ground of some variability in factor substitution.

III. *Factor Price Adjustments*

In the discussion of Cases 2, 3, and 4 in the preceding sections, one of the key elements was the behavior of the relative price of materials to domestic factors in going from one tariff policy to another. This question is ignored or else treated in partial equilibrium terms in the literature on value-added and on the theory of effective protection.

To highlight the nature of the problem we are dealing with, consider the following

[7] Note that this argument applies only to Cases 2, 3, and 4 where factor price adjustments are admitted.

As a referee pointed out, this proposition will be difficult to test in less developed countries where many industries come into being after protection is granted.

[8] I have extended the analysis to cover situations of nonconstant returns to scale, monopoly, factor market distortions, and learning effects, but space limitations prohibit their inclusion here.

simple model with two sectors; an importable dependent on labor and an imported input, and an exportable dependent on labor, imported input (material), as well as on a fixed factor, G. The introduction of the fixed factor is to prevent complete specialization since labor is the only other primary factor. We abstract from problems of tariff redundancy, monopoly, nonconstant returns to scale, and factor market distortions.

Let

$$(7)\quad \begin{aligned} Z_1 &= Z_1(L_1, M_1) \text{ importable} \\ Z_2 &= Z_2(L_2, G, M_2) \text{ exportable} \end{aligned}$$

Setting unit cost equal to price:

$$(8)\quad \begin{aligned} a_{1L}w + a_{1m}P_m &= P_1 \\ a_{2L}w + a_{2m}P_m + a_{2g}r &= P_2 \end{aligned}$$

where a_{ij} = amount of input j used per unit of output i.

Totally differentiating (8), dividing through by the respective output price, and letting

$$\hat{P}_1 \equiv \frac{dP_1}{P_1} \text{ and } C_{ij} \equiv \frac{a_{ij}\lambda}{P_i}, \qquad \begin{aligned} i &= 1, 2; \\ j &= L, g, m, \\ \text{as } \lambda &= w, P_m, r; \end{aligned}$$

$$\hat{a}_{ij} \equiv \frac{da_{ij}}{a_{ij}}$$

In general, the ˆ denotes proportionate change.

We get:

$$(9)\quad \begin{aligned} C_{1L}\hat{w} + C_{1L}\hat{a}_{1L} + C_{1m}\hat{P}_m + C_{1m}\hat{a}_{1m} &= P_1 \\ C_{2L}\hat{w} + C_{2L}\hat{a}_{2L} + C_{2m}\hat{P}_m + C_{2m}\hat{a}_{2m}& \\ C_{2g}\hat{r} + C_{2g}\hat{a}_{2g} &= \hat{P}_2 \end{aligned}$$

A necessary cost minimizing condition is:

$$\begin{aligned} wda_{1L} + P_m da_{1m} &= 0 \\ wda_{2L} + P_m da_{2m} + rda_{2g} &= 0 \end{aligned}$$

which become, in terms of C_{ij}, factor shares in unit costs:

$$(10)\quad \begin{aligned} C_{1L}\hat{a}_{1L} + C_{1m}\hat{a}_{1m} &= 0 \\ C_{2L}\hat{a}_{2L} + C_{2m}\hat{a}_{2m} + C_{2g}\hat{a}_{2g} &= 0 \end{aligned}$$

Therefore, (9) becomes:

$$(11)\quad \begin{aligned} C_{1L}\hat{w} + C_{1m}\hat{P}_m &= \hat{P}_1 \\ C_{2L}\hat{w} + C_{2m}\hat{P}_m + C_{2g}\hat{r} &= \hat{P}_2 \end{aligned}$$

Now consider a differential tariff structure such as we examined in our earlier discussion, with a tariff on the final importable and no tariff on the intermediate good or exports, i.e. $\hat{P}_1 > 0$, $\hat{P}_2 = \hat{P}_m = 0$.

From equation (11) we get immediately:

$$(12)\quad \hat{w} = \frac{\hat{P}_1}{C_{1L}} > 0$$

Since the denominator is the share of labor in unit cost of production of the final importable, it is necessarily less than one. Hence the wage rate rises *more* than proportionately when a tariff is imposed on the final importable. Conversely, going from a tariff situation to one of free trade, the wage rate will *fall* more than proportionately. Since P_m, the material price is fixed, this means that if the final importable industry does not operate on a Leontief technology, it may well display negative value-added in world prices but yet may be viable when allowed to adjust to world prices.

In terms of a more general model where both final goods industries depend on *two* domestic factors, say, capital and labor, as well as on imported material, wages and rents move in *opposite* direction, depending on capital-labor ratios. (A. H. H. Tan, 1969a.) Thus there is *both* substitution towards and away from material input. Nevertheless, in terms of our value-added measure, the *critical* point is that the two-way substitution is not exactly offsetting, i.e., we would observe (in a non-Leontief technology), a net substitution either away *from* or *towards* material input. The implication of this is that industries displaying either positive or negative value-added may be viable under free trade if the net substitution is towards the domestic factors. If, instead, the net substitution is towards material inputs, then, in the absence of tariff redundancy or monopoly, the industries would go out of existence under free trade.

IV. *EP Rates and Maximum Factor Rewards*

The first claim of *EP* theory, that it provides a measure of the maximum proportionate increase in factor rewards permitted by a tariff structure, as compared to a free trade regime, can be readily disposed of. In the first place, the theory does not apply to cases where industries are viable in the tariff situation but not in the pre-tariff situation. However, even when industries are viable in both situations, there are difficulties.

Consider Case 1 of Section I: quite clearly, according protection *solely* to a small industry cannot affect the remuneration to domestic factors. What is likely to happen is either unimputed gains to the entrepreneur, who may or may not be considered a domestic factor, or the tariff is redundant.

What about Case 2 of a small industry, which is confronted with a broadly similar differential structure of protection across many such industries? The effect on domestic factor rewards must be analyzed from a general equilibrium vantage-point. The *EP* interpretation is clearly invalid for this case since, to a small industry, factor prices are given.

The *EP* interpretation fits our Case 3, the large industry case, *if no tariff changes elsewhere are being considered.* However, the latter is clearly not the premise of *EP* theory since more than one *EP* rate is considered. It is clear that *EP* theory deals with our Case 4, the large industry case with simultaneous changes in tariffs in many industries, *but in partial equilibrium terms.* From a purely partial equilibrium standpoint, in order to attract additional resources, the industry must offer increasing factor prices. We note that *EP* theory implicitly imputes all the increase in product price (due to protection) to the return on the domestic factor(s).

V. *EP Rates and Resource Allocation*

The second goal of *EP* theory is to indicate the resource-allocative effects of a tariff structure. The measured rates are ordered on a scale through zero:

> . . . if four activities producing traded goods can be ordered along a scale A, B, C, D, in ascending order of effective rates, we can say that output of A must fall and of D must rise and that resources will be pulled from A to B and from A and B to C; but without more precise information about production-substitution elasticities, we cannot say whether the outputs of B and C will rise or fall. [Corden 1966, p. 224]

The quotation above indicates that only the *ranking* of *EP* rates matter and that resources will move from sectors with lower *EP* rates to those with higher, since *EP* rates are interpreted to represent increases in the rates of remuneration to domestic factors. We shall demonstrate below that *EP* rates predict only a *particular* direction of resource flows whereas general equilibrium analysis, with variable input coefficients, indicates that flows contrary to *EP* prediction are possible. Two examples are provided: one, where there is a uniform tariff (subsidy) on final goods; and two, where one final sector has a higher nominal tariff than the other and there is no tariff on material imports. As will become apparent, the crux of the matter is that *EP* rates depend *not only* on nominal tariffs but *also* on value-added. The latter is a function of technology as well as relative output-input prices.

Consider again the simple model of Section III above. We shall present two cases to show the ambiguity of *EP* theory. In *Case A*, the tariff on the final importable is equal to the subsidy on the exportable. In *Case B*, the tariff on the final importable is less than the export subsidy. There is no tariff on material imports in either case.

Case A

Under a uniform tariff and subsidy on the final goods,

$$\hat{P}_1 = \hat{P}_2 \quad \text{and} \quad \hat{P}_m = 0.$$

From equation (11) we get, again, that wages increase as in equation (12).

The rental on the fixed factor, (G), may, however increase or decrease:

From equations (11) and (12),

$$(13) \quad \hat{r} = \frac{\hat{P}_1(C_{1L} - C_{2L})}{C_{2g}C_{1L}} \gtrless 0 \quad \text{as } C_{1L} \gtrless C_{2L}$$

To return to the mainstream of the discussion, we look next at factor endowment.

$$(14) \quad \begin{aligned} a_{1L}Z_1 + a_{2L}Z_2 &= L \\ a_{2g}Z_2 &= G \end{aligned}$$

Totally differentiating equation (14) and converting to proportionate terms, letting

$$F_{ij} = \frac{a_{ij}Z_i}{\sum_i a_{ij}Z_i} = \begin{array}{l}\text{fraction of supply of factor} \\ j \text{ used in sector } i\end{array}$$

and noting

$$\sum_i F_{ij} = 1,$$

we get:

$$(15) \quad F_{1L}\hat{Z}_1 + F_{1L}\hat{a}_{1L} + F_{2L}\hat{a}_{2L} + F_{2L}\hat{Z}_2 = 0$$

and

$$F_{2g}\hat{Z}_2 + F_{2g}\hat{a}_{2g} = 0$$

or

$$\hat{Z}_2 = -\hat{a}_{2g}$$

Next consider the production function Z_2, from equation (7). By the linear homogeneity property, we can write:

$$Z_2 = Gf_2\left(\frac{L_2}{G}, \frac{M_2}{G}\right)$$

Hence

$$\frac{1}{a_{2g}} = f_2\left(\frac{L_2}{G}, \frac{M_2}{G}\right)$$

Totally differentiating,

$$(16) \quad \hat{a}_{2g} = -a_{2g}\left[f_{2L}d\left(\frac{L_2}{G}\right) + f_{2m}d\left(\frac{M_2}{G}\right)\right]$$

We know the partial derivatives, being marginal physical products, are positive, i.e. $f_{2L}, f_{2m} > 0$. However, the total derivatives, $d(L_2/G)$ and $d(M_2/G)$, are dependent on relative input prices, P_m, r, and w. P_m is fixed; we know w always rises (equation (12)) but r may rise or fall (equation (13)). In addition, in a three-input world, two of the inputs can be complements. Hence, in general, the two total derivatives on the right-hand side of (16) may take either sign. Therefore $\hat{a}_{2g}$ may take either sign. Returning to equation (15) we therefore see that Z_2 may rise or fall, i.e. output of sector 2 may increase or diminish under a uniform tariff subsidy on final outputs.

Now let us look at what *EP* theory has to say. Suppose value-added in sector 2 exceeds that in sector 1. Then, since *EP* rates are given by:

$$(17) \quad T_i = \frac{t_i}{W_i^*}$$

where t_i = nominal tariff (subsidy) on sector i, it follows that W_i^* = *equilibrium* value-added in world prices in sector i.

This implies $T_1 > T_2$, *EP* rate of sector 1 exceeds *EP* rate of sector *2 even though both enjoy a uniform tariff/subsidy.* According to Corden, therefore, resources will flow from sector 2 to sector 1. But we have seen that this is not necessarily the case in general equilibrium with input substitution. *The Corden approach*[9] *totally ignores the general equilibrium role of material imports, factor-material substitution, and has no resource availability constraint.*

Case B

For the second case, let $t_1 < t_2$, i.e. let the export subsidy exceed the final import tariff. Then $\hat{P}_2 > \hat{P}_1$. The wage-rate, w, rises as before (equation (12)). However, the rental, (r), on the fixed factor, (G) is now given by:

$$\hat{r} = \frac{C_{1L}\hat{P}_2 - C_{2L}\hat{P}_1}{C_{1L}C_{2g}} \gtrless 0 \quad \text{as } C_{1L}\hat{P}_2 \gtrless C_{2L}\hat{P}_1 \tag{18}$$

Again, r can either rise or fall. The same arguments in Case A apply, i.e. sector 2 may either expand or contract.

Even though $t_1 < t_2$, *EP* rates may be such that $T_1 > T_2$ as in Case A, if value-added in sector 2 exceeds that in sector 1 sufficiently. Again, *EP* theory predicts a *particular* flow of resources, from sector 2 to sector 1, when the reverse flow is possible in general equilibrium and variable input proportions.

[9] The reference is to Corden's original contribution 1966.

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